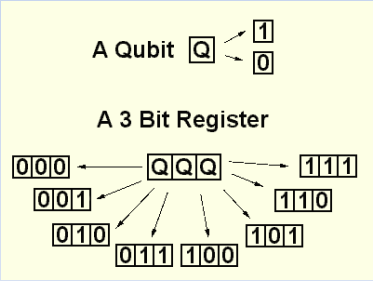
Functioning Von Neumann Architecture Recreated on a Quantum Device

By Christopher Gibbs

History:

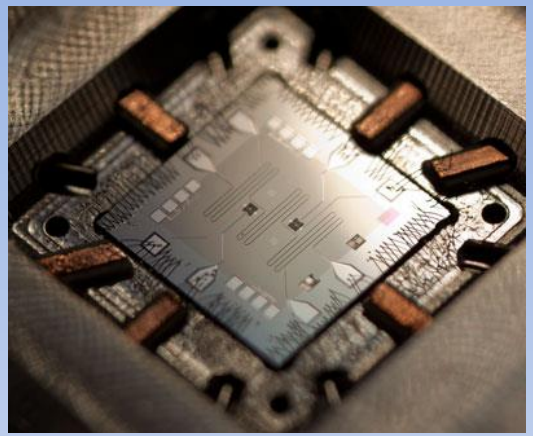
The field of quantum computing was introduced by Yuri Manin in 1980 and Richard Feynman in 1982. The concept was to be able to make use of quantum mechanical phenomenon to perform computation.

Like bits in a conventional computer, quantum information is stored on quantum bits of "qubits". However, qubits are 2-state systems and allow for a superposition of both states simultaneously.



Progress has been slow in creating such devices because of the difficulty involved in maintaining quantum states.

The Device:



The device created in 2011 by a team of physicists in California is claimed to run a basic Von Neumann architecture (Central Processing Unit and separate RAM) running on 2 qubits (each 2 pieces of superconducting material with state determined by phase difference between electrodes) each with their own quantum RAM ("quRAM", superconducting resonator that stores information as trapped microwaves)

The device is still in infancy and lacks the coherence times (how long quantum states remain), the fidelity, and the size (current work is being done on increasing the number of quantum devices integrated per chip) to be practical.

Setbacks:

The most difficult part of designing a quantum computer is difficulty increasing coherence time. Because of the nature of the subatomic particles, their quantum properties are very easily altered. Due to this, quantum computing is for the most part impractical until a way to suitably increase coherence times has been developed.

Potential:

Though a quantum computer will not necessarily outperform a conventional machine at all tasks, through the use of complex algorithms such as Shor's Algorithm and Grover's Algorithm, they will theoretically be able to significantly outperform them.

Example: In theory it would take longer than the age of the universe to crack RSA 140 (security encryption with 140 digits) on conventional machines. Also in theory, a quantum machine running Shor's Algorithm could crack it in a matter of seconds.